

Central Track Simulation Updates

Nick Lukow
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Tracking Simulation Updates

- TPC parameters can now be changed
 - Longitudinal resolution and dispersion
 - Transverse resolution and dispersion
 - Pad size
- Now looking at uRWELL simulations with multiple hits per layer
- Added DIRC material to simulation
- Added a new parameter extraction layer behind the DIRC
- Added p_t resolution histograms to the code
- Investigated TPC hits as a function of the polar angle

DIRC Material

- Added DIRC material to simulation
 - Total material: 17.5%
- Reconstructed track parameters can also be extracted from behind the DIRC now

https://wiki.bnl.gov/conferences/images/5/5e/RD_2011-2_EIC_DIRC_FY12_proposal.pdf

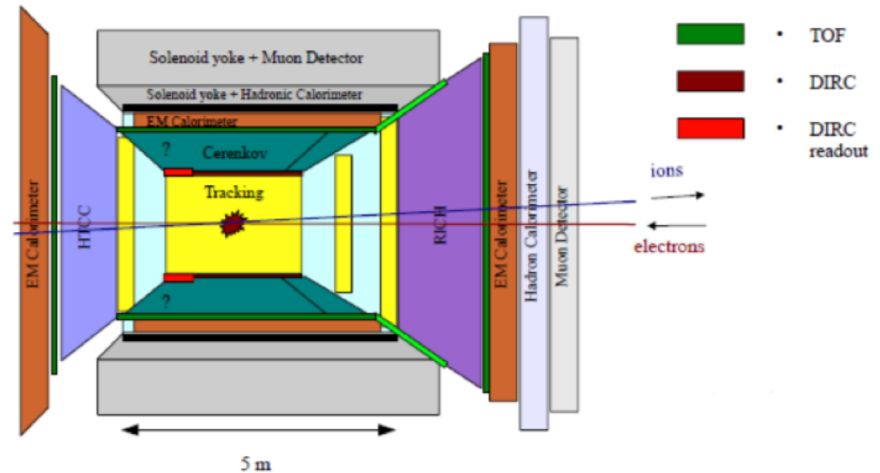


Figure 11: Detector cartoon showing the DIRC inside of the supplementary gas Cherenkov (Option 2).

Compared with Option 1, Option 2 has three main advantages:

1. Reducing the radius (and length) of the DIRC makes it significantly less expensive.
2. The proximity to the central tracker gives a better angular resolution for the incident track.
3. The shorter DIRC bar will suffer less from chromatic dispersion and will offer better timing.

There are, however, also some disadvantages:

1. Adding 0.15 - 0.20 r.l. of material in front of the gas Cherenkov will expose it to δ -electrons.
2. The proximity to the collision point will increase the solid angle covered by the expansion volume.
3. The increased distance to the TOF will reduce the timing benefits of the TOF detector.
4. It would not allow extending the DIRC bars outside of the endcap as they would interfere with the electron tracking at intermediate angles.

Simulations Generated

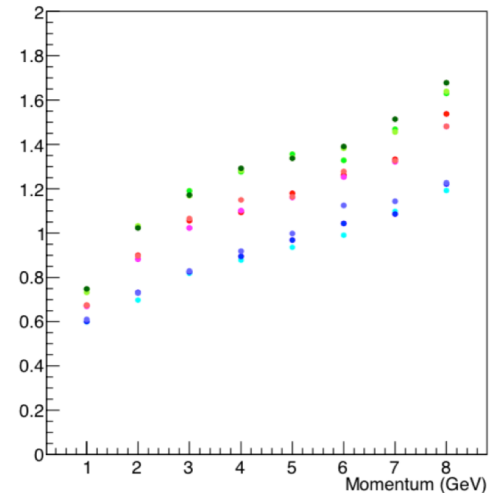
- Simulation samples with every combination of the following detector options was created:
 - For the TPC:
 - Transverse Resolution: {70, 90, 110} μm
 - Transverse Dispersion: {20, 40, 60} $\mu m/\sqrt{D}$
 - Longitudinal Resolution: {250, 500} μm
 - Longitudinal Dispersion: {0.5, 1.0, 1.5} $\mu m/\sqrt{D}$
 - Pad Size: {0.5, 1.0}. cm
 - For the uRWELL:
 - Intrinsic Resolution: {100, 150} μm
 - Hits per Layer: {1, 3, 5}
- Each detector configuration was tested with simulations for every combination of:
 - Electron momentum: {1, 2, 3, 4, 5, 6, 7, 8}
 - Electron polar angle: {43, 66, 89}
 - Parameterization done at:
 - Interaction Point
 - DIRC
 - Post-DIRC

NOTE: Following slides only show DIRC parameterizations for 66 Degree electrons, 1000 events per point

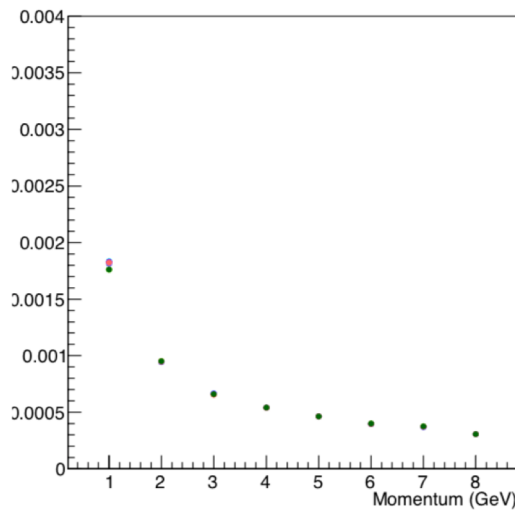
TPC – Transverse Resolution/Dispersion

- Residuals are mostly sensitive to the dispersion ($20/40/60 \mu\text{m}/\sqrt{D}$)
- Most sensitivity is in momentum/ p_t
- Little sensitivity in phi
- Effectively no sensitivity in theta
- Experimental results give estimates for these values (Resolution: 90, Dispersion: 40)

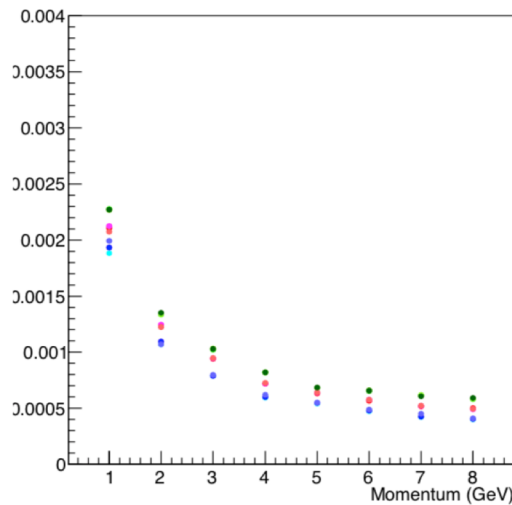
Pt Resolution for 66 degree Electrons at DIRC



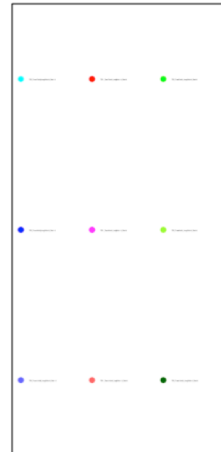
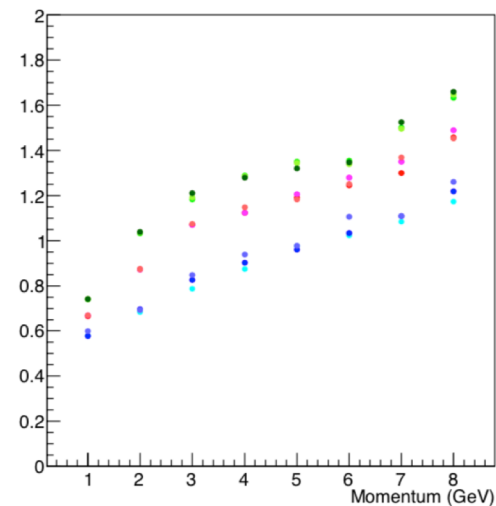
Theta Resolution for 66 degree Electrons at DIRC



Phi Resolution for 66 degree Electrons at DIRC

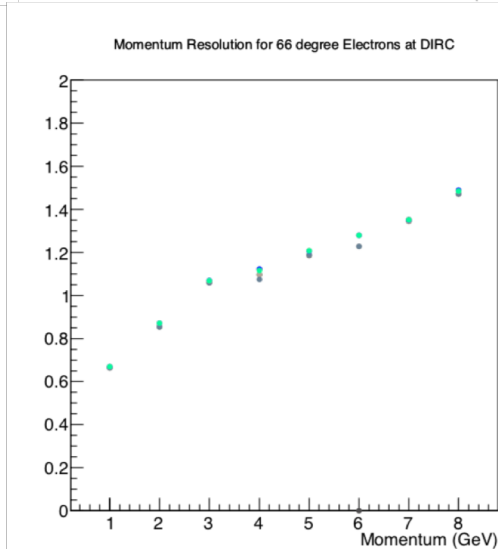
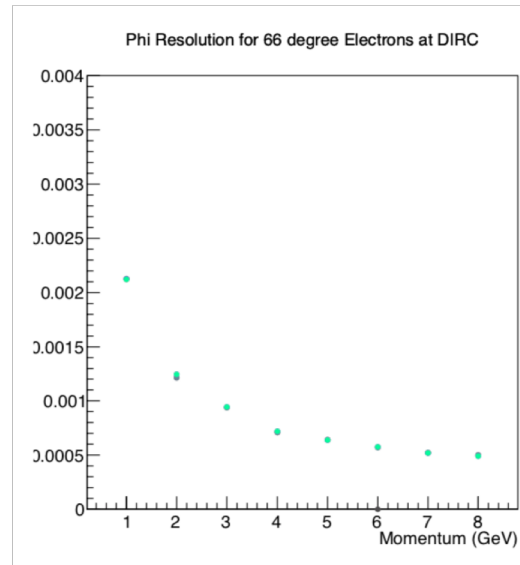
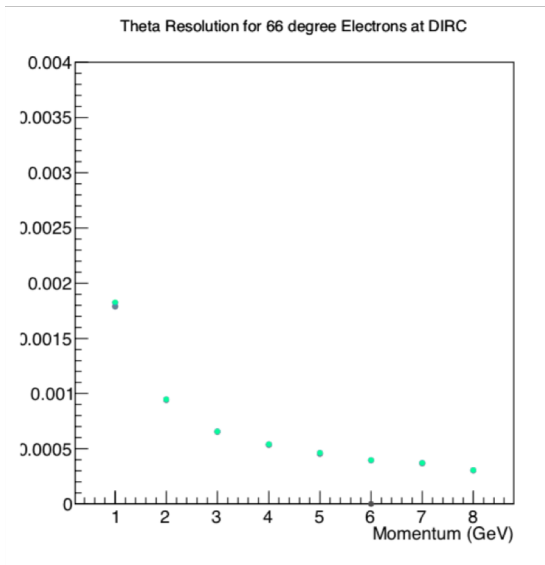
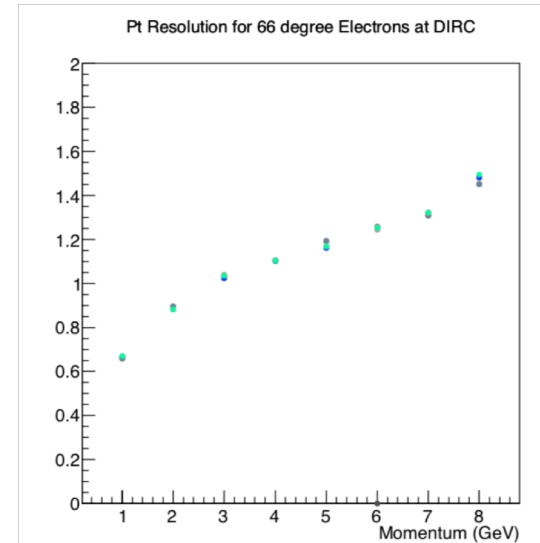


Momentum Resolution for 66 degree Electrons at DIRC



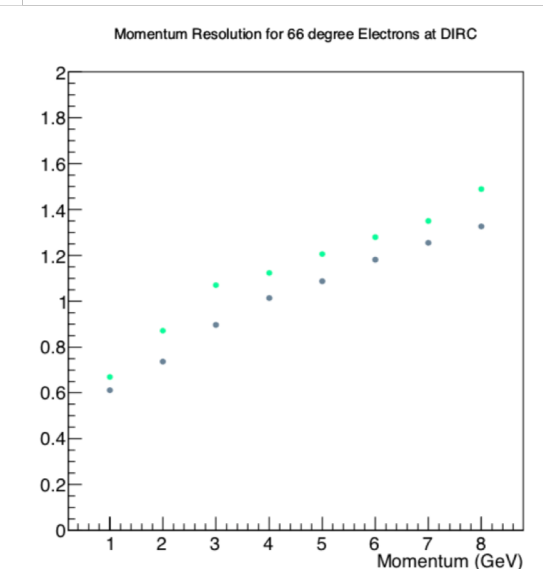
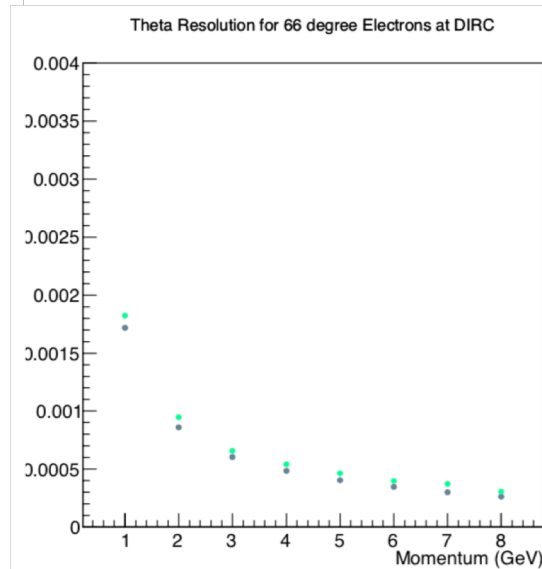
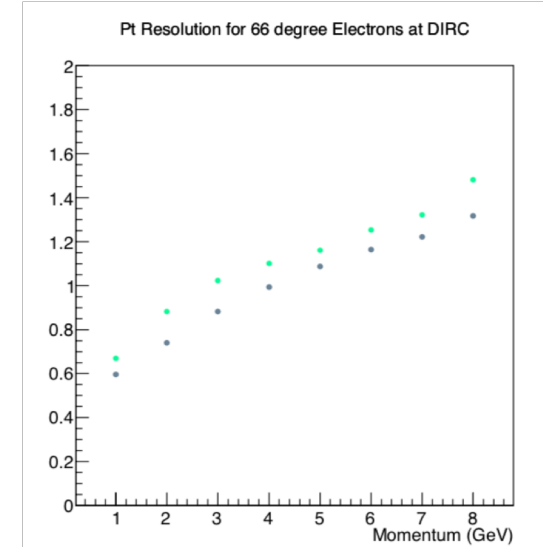
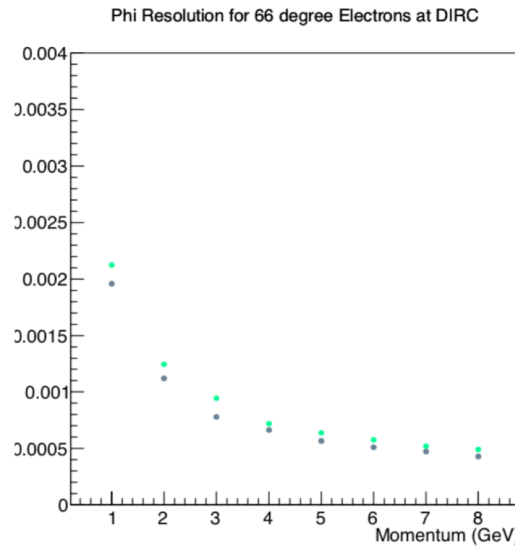
TPC – Longitudinal Resolution/Dispersion

- Residuals largely insensitive to the parameter changes investigated (nominal values in **bold**)
 - Intrinsic resolution: 250 and **500** μm
 - Dispersion: 0.5, **1.0**, and $1.5 \mu m/\sqrt{D}$
- These are the values for which there is no experimental results for
 - But there is little sensitivity to these values when varying by %50 of the default values

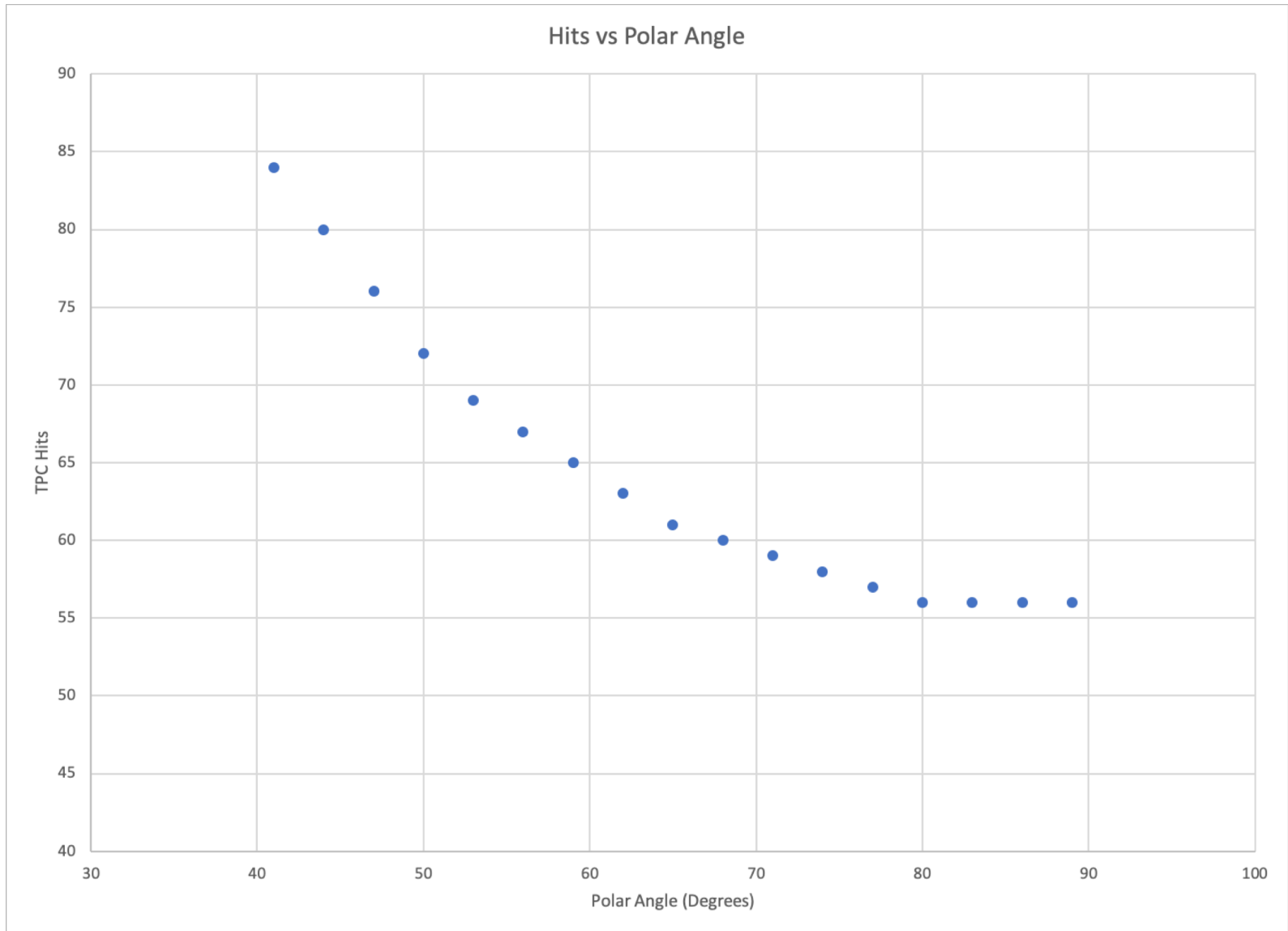


TPC – Pad Size

- Each parameter shows a dependence on the pad size. With smaller pad sizes performing better.
 - 0.5 cm
 - 1.0 cm (more realistic)



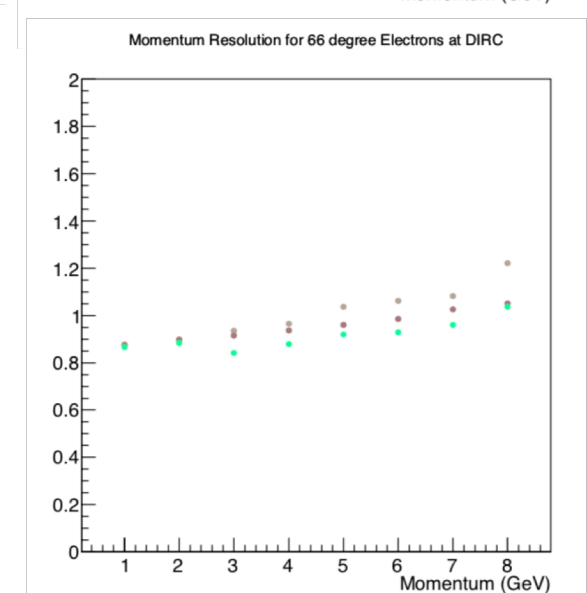
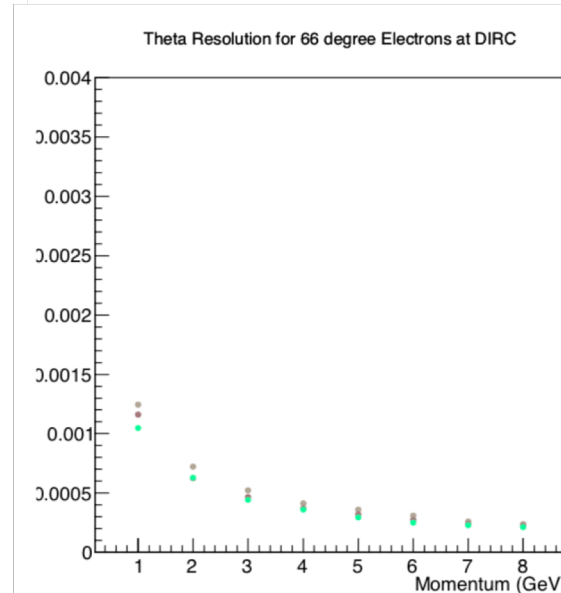
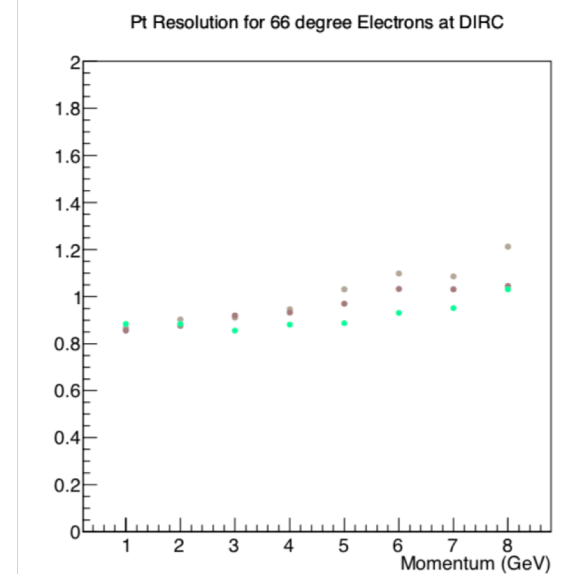
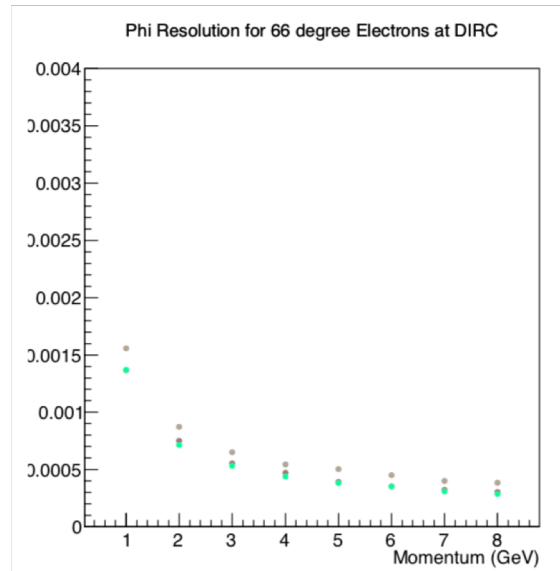
TPC – Hits as Function of Angle



uRWELL – Hits per Layer

- Each parameter shows a dependence on the number of hits. With more hits performing better.

- 1 Hit
- 3 Hits
- 5 Hits



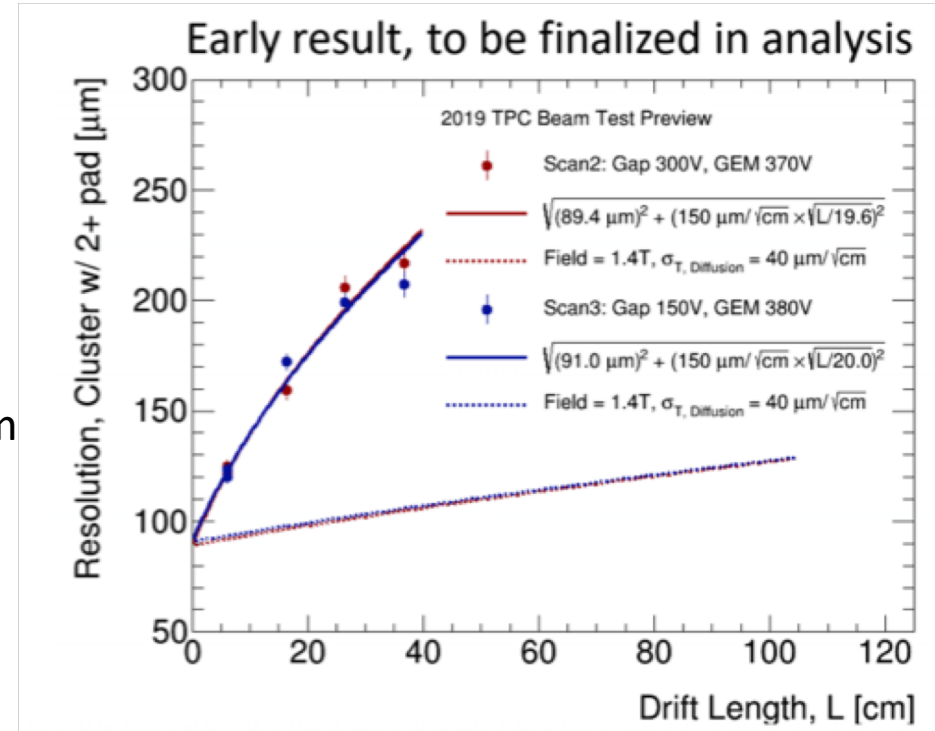
Summary

- Can now investigate more parameters in the TPC and uRWELL designs
 - What TPC parameter values should I investigate?
 - Current investigations used arbitrarily varied values. Any suggestions based on expertise?
- Can now examine track parameters outside past the DIRC
- Simulation is ready to examine placing an extra tracking layer in the TPC design, either in front of the DIRC or behind the DIRC
 - Haven't run large simulation sets for this yet

Backup

sPHENIX TPC Resolution Parameters

- Values from beam test:
 - Intrinsic transverse resolution: 90 μm
 - Transverse dispersion: 40 μm
- Values that remain at default:
 - Intrinsic longitudinal resolution: 500 μm
 - Longitudinal dispersion: 1 μm
 - Intrinsic radial resolution



From Jin Huang's [presentation](#) (slide 33)